

## HEATING APPARATUS

### BACKGROUND OF THE INVENTION

#### FIELD OF THE INVENTION

The present invention relates to an apparatus for heating a body at large, and more particular, to an apparatus for heating a fluid such as a liquid or a gas, or a heating apparatus used for a weld machine of polyethylene, or the like.

#### DESCRIPTION OF THE RELATED ART

As a technique for heating a circulating liquid, for example, JP-A-2002-119586 describes extending a pipe, through which blood or the like flows, in the water, and cooling or heating the water to perform temperature control of blood (Patent document 1, Fig. 1, or the like). That is, a bag-shaped receiving body provides therein a pipe and receives therein a heat-exchanging fluid, the receiving body being provided with an inlet and a discharge outlet for the heat-exchanging fluid to afford circulation of the heat-exchanging fluid. And temperature control means for the heat-exchanging fluid is separately provided outside of the receiving body whereby temperature control is performed on the heat-exchanging fluid in the receiving body and further on blood, which passes through the pipe in the heat-exchanging fluid. Also, as a heat generating apparatus for melting snow at a branch point in railway, JP-A-2000-58234 describes a technique, in which a heat

generating body is interposed by synthetic resin sheets and a resulting product is pressed by an epoxy resin into a heat radiating body (Patent document 2).

[Patent document 1] JP-A-2002-119586

[Patent document 2] JP-A-2000-58234

In the technique described in Patent document 1, it is necessary to separately prepare a heat-exchanging fluid having been controlled at a predetermined temperature, which is a work imposing a burden in emergency medical sites or the like, in which blood transfusion is needed. Since the heat-exchanging fluid is large in amount and heat capacity as compared with blood or the like, which is an object being heated, heating means becomes large to need a predetermined time for warming. In the technique described in Patent document 2, thermal efficiency in connection with the heat radiating body is enhanced since a resin sheet and an epoxy resin are provided between the heat generating body and the heat radiating body. The heat radiating body itself is not an object being directly heated, but snow and hamburger brought into contact with the heat radiating body constitute an object being heated, so that heating efficiency is not so much enhanced when contact between such object being heated and the heat radiating body is not adequate. In particular, when an object being heated is a gas or a liquid, which can be heated only through tube or the like, and when an object being heated has a complex surface configuration,

a gap is formed between a heating apparatus and the object being heated, whereby an efficient and stable heating is difficult to perform.

#### SUMMARY OF THE INVENTION

It is an object of the invention to provide a heating apparatus, which is able to perform an efficient and stable heating, and simple and easy to handle.

To solve the problem, the invention provides a heating apparatus comprising a heater and a flexible, thermal conductive member, which contacts with the heater, and wherein an object being heated is brought into contact with the thermal conductive member to be heated. In the invention, the heating apparatus comprises therein a space, in which a container containing a gas or a liquid is received, and the container is detachable to permit a gas or a liquid to flow therethrough. Also, to solve the problem, the invention provides a further heating apparatus comprising a heater, a detachable container, through which a gas or a liquid flows, and a flexible, thermal conductive member, which contacts with the heater, and wherein the container is brought into contact with the thermal conductive member to heat a gas or a liquid. It is possible to use a silicone resin and fluoro resin for the thermal conductive member.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view showing a state, in which a heating apparatus according to the invention is opened;

Fig. 2 is an enlarged, cross sectional view showing heating means;

Fig. 3 is a plan view showing a state, in which the heating apparatus according to the invention is closed;

Fig. 4 is a plan view showing a cassette container for blood transfusion;

Fig. 5 is a cross sectional view showing the cassette container; and

Fig. 6 is a block diagram showing a state of the heating apparatus in use.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of a heating apparatus according to the invention will be described with reference to the drawings. Fig. 1 is a plan view showing a state, in which a heating apparatus 1 according to the invention is opened. Two lids 2a, 2b are connected to each other by hinges 3 to be openable. The heating apparatus 1 comprises one or more heating means, and a plurality of heating means 4 are provided on the respective lids 2a, 2b in the embodiment. Fig. 2 is an enlarged, cross sectional view showing heating means 4. The reference character 4a denotes a heater, that is, heat generating means. The heat generating means mainly uses a heater with electric resistance. And provided

on an upper surface of the heater 4a is a flexible, thermal conductive member 4b. The flexible, thermal conductive member in the invention suffices to comprise a substance, which possesses thermal conductivity suited to usage for heating apparatuses, follows a surface configuration of an object, being heated and contacted by the substance, to be deformed to be able to closely contact the surface configuration without any gap, and does not flow in use. Accordingly, metal or the like, which is good in thermal conductivity but hard and difficult to be deformed, is excluded. For example, fluororesin, thermal conductive silicone, or the like is suited to the purpose. The thermal conductive member 4b is arranged to constitute a surface as shown in Fig. 1. Also, temperature detection means 5 such as thermocouple is provided. The heater 4a and the temperature detection means 5 are connected to a control device 6 to be controlled to a predetermined temperature by means of control means such as PID control.

Fig. 3 is a plan view showing a state, in which the heating apparatus 1 according to the invention is closed. Fig. 4 is a plan view showing a cassette container 10 for blood transfusion, and Fig. 5 is a cross sectional view showing the cassette container. The cassette container 10 comprises therein a zigzag-shaped pipe, through which blood flows, and is detachable from the heating apparatus 1. In Fig. 3, the cassette container 10 is interposed between the two lids 2a, 2b in a sandwiched

manner. As shown in Fig. 4, portions around the pipe serving as a flow passage for blood are thickened as compared with portions without the pipe, so that the cassette container 10 has a surface configuration with irregularities. Here, when heating means such as ordinary metallic plate is used, it only contacts a top of the pipe, so that a large gap is produced between the heating means and the cassette container to degrade the heating efficiency. Heating becomes stable with the lapse of time, in which case a cold blood is transfused into a patient until heating becomes stable, and so such state is not preferable. Also, contact is more or less improved by working surfaces of heating means in conformity to the surface configuration of the cassette container, but such measure involves a limit and such work with high accuracy leads to an increase in cost. Further, assembly must be made so that irregularities on the surfaces of the heating means, which interposes the cassette container from above and below, correspond completely to each other, and therefore it is difficult to realize a simple heating apparatus. Also, heating means is used plural times while cassette containers are ordinarily throwaway, so that it is not possible to fix and fill an epoxy resin or the like between the heating means and a cassette container.

According to the embodiment, since the flexible, thermal conductive member 4b is provided on the upper surface of the heater 4a, the thermal conductive member 4b follows a surface

configuration of the cassette container 10 as shown in Fig. 5 to be deformed to closely contact the surface configuration without any gap, so that heat of the heater 4a is efficiently conducted to the cassette container 10 to raise blood, which passes through the pipe, to an appropriate temperature (temperature near a body temperature) from the beginning.

Provided on an external surface of the lid 2a are temperature indication means 7, a light emitting diode 8 and an alarm buzzer 9.

Fig. 6 is a block diagram showing a state of the heating apparatus in use. A pump 11 feeds a predetermined amount of blood to the cassette container 10. A flow rate is appropriately selected according to a situation, in which blood transfusion is performed, and mainly in the range of 5 to 50 ml/min. Blood passing through the cassette container 10 is heated by the heating apparatus 1. In the example, an electric power source for the heating apparatus 1 supplies a direct current at 12 V, and so a battery power source for automobiles such as emergency cars is usable. In an environment of an AC power source, a power supply 12 is provided outside to supply a direct current at 12 V. Thereby, there is no need of providing a large power supply within the heating apparatus 1 and so it is possible to make the apparatus small in size. A power supply for supplying of a direct current at 12 V is also used as a drive power supply for the control device 6. In the example, five heaters and three

temperature detection means 5 are used to heat blood to a temperature near a body temperature while the control device performs PID control. Temperature detected by the temperature detection means arranged most downstream is displayed on the temperature indication means 7. Blood having passed through the heating apparatus 1 is transfused into a patient while maintained at an appropriate temperature. In addition, with the example, when even one among the temperature detection means 5 provided exceeds 40°C, abnormality is judged to stop heating, light up the light emitting diode 8 and to sound the alarm buzzer 9, thus issuing warning. When blood transfusion is terminated, the cassette container 10 is removed and the flexible, thermal conductive member 4b is restored to a substantially original configuration.

While the embodiment of the invention has been described by way of heating of blood for transfusion, the invention is not limited thereto. Heating of an infused substance in artificial dialysis, infusion of various medical fluids, or the like can be performed besides blood transfusion. Also, the invention is applicable to thermal welding of polyethylene film or the like. By covering an object with a package film such as polyethylene film and heating the object by means of a heater through the flexible, thermal conductive member, it is possible to have a package film following a surface configuration of the object to efficiently heat the film in a closely adhered



condition. Besides, it is possible to hold the flexible, thermal conductive member against various objects having a complex surface configuration to efficiently heat the objects, and by putting gaseous and liquid fluids in a container and holding the flexible, thermal conductive member against the container, it is possible to efficiently heat the fluids without bringing the fluids directly into contact with the heating apparatus.

As described above, the heating apparatus according to the invention comprises a flexible, thermal conductive member adapted to contact with a heater, and can bring an object being heated into contact with the thermal conductive member to have the same following a surface configuration of the object being heated to bring the flexible, thermal conductive member into close contact with the object without a gap, thus efficiently heating the object. Since there is no need for any heat exchanging fluid and heating means therefor, it is possible to realize a simple heating apparatus, which is easy to handle, and of high utility value in sites for emergency medical treatments such as blood transfusion.